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Logging System Cost Analysis

Comparison of Methods Used

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LOGGING SYSTEM COST ANALYSIS: COMPARISON OF METHODS USED

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It has become increasingly difficult to plan logging operations to minimize costs and maximize profits. A variety of factors, including new harvesting equipment, smaller timber, scattered logging areas, lighter volumes per acre, inflation, and rising production and labor costs contribute to planning difficulties. Some of these factors are outside the control of logging management. However, a good knowledge of logging costs and their methods of calculation helps keep operations on a sound business basis.

Since cost analysis is vital to the success of logging operations, logging managers and others concerned with calculating machine rates and logging costs should become familiar with different cost analysis methods so that they may find one appropriate to their needs.

Choosing the right cost analysis method has been difficult because of the large number of methods—an incomplete literature review found 30 different ways of calculating machine rates and logging costs—and a lack of uniformity in defining the components used in the methods. If an inappropriate method is chosen or incorrect information is used in the calculations, the erroneous results may lead to poor decisions regarding the total logging operation.

In costing logging equipment, both the machine rate and cash flow approaches are used, although the machine rate method seems to predominate. To substantiate the charge that the lack of uniformity causes problems, it is noted that the machine rate method can employ either "scheduled hours" or "productive hours" or an erroneous combination of both.

To help managers best determine logging costs, this paper examines the use of three different cost analysis methods in determining the cost of a single piece of logging equipment and an entire logging system. Suggestions for using each of the three methods are given.

METHODS

Definitions of Terms

When discussing logging costs, a clear definition of all terms is important.

Total Time (TT) (Rolston 1968): The total elapsed time for the period under consideration. In 1 year the total time would be 365 24-hour days or 8,760 hours.

Scheduled Hours (SH): The total annual hours a machine is scheduled to do productive work. If a machine is intended to work 200 8-hour shifts, the scheduled hours would be 1,600.

Productive Hours (PH) (Rolston 1968): That scheduled time portion during which the machine actually works. If SH were 1,600 hours but the machine actually worked only 1,120 hours the PH would be 1,120 hours.

Machine Utilization (U) (Miyata 1980): The percentage of SH the machine actually works. In the above example, machine utilization is (1,120 ÷ 1,600) × 100, or 70 percent.

Fixed Costs (FC) (Miyata 1980): Costs incurred whether or not the machine is productively employed. They depend not on the amount of work done by the machine, but on the passage of time, and commonly include **Depreciation (D),** and **Interest, Insurance, and Taxes (IIT).**

Depreciation (D): The gradual decline in equipment value usually calculated for income tax purposes. Straight line depreciation is usually used for equipment machine rates and logging cost calculation.

Interest, Insurance, and Taxes (IIT): Interest is the cost of using funds—borrowed or taken from savings or equity—over a period of time. If the money

comes from personal savings or established equity, an opportunity cost (the rate this money would earn if invested elsewhere, e.g., in U.S. savings bonds or a savings account), should be used as the interest rate. The equipment owner also pays property or usage taxes on his equipment as well as insurance premiums.

Operating Costs (OC) (Miyata 1980): Costs incurred because of the machine's productive activity. Such costs depended on PH and the number of units produced, and vary with hours of use. Typical OC include the cost of fuel, oil and lubricants, maintenance and repair necessary to keep a machine in good running condition and major supplies such as rigging and tires.

Hourly Machine Cost per PH (HMC/PH): Total hourly cost of owning and operating a machine based on productive hours and given by:

$$HMC/PH = \frac{FC + OC}{PH}$$

Hourly Machine Cost per SH (HMC/SH): Total cost of owning and operating a machine based on scheduled hours and given by:

$$HMC/SH = \frac{FC + OC}{SH}$$

The following formula expresses the relation between fixed and operating costs and it can be shown graphically as in figure 1.

$$C = FC + OC$$

Where: C = Total cost for any time period.
FC = Fixed cost for any time period.
OC = Operating cost for any time period or HOC × PH.
PH = Number of productive hours.
HOC = Operating cost per productive hour.

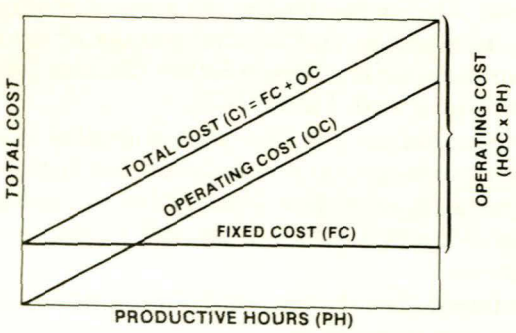

Figure 1.—*Relation between fixed and operating costs.*

Figure 1 shows that the greater the number of productive hours for any time period, the smaller the proportion of fixed cost is to total cost for that period. Conversely, the smaller the number of productive hours, the greater the proportion of fixed cost is to total cost.

FORMULAS USED

Methods of Calculating Hourly Machine Rate for Equipment

Three predominant methods have been chosen to calculate the hourly machine rate for equipment. They are described below:

Method 1: The sum of the fixed and operating cost per year is divided by the **scheduled** hours per year to obtain a machine rate per scheduled hour.

$$\text{Machine rate based on SH(\$/SH)} = \frac{FC + OC}{SH}$$

Method 2: The sum of the fixed and operating cost per year is divided by productive hours per year to obtain the machine rate per productive hour.

$$\text{Machine rate based on PH (\$/PH)} = \frac{FC + OC}{PH}$$

Both Method 1 and Method 2 are mathematically correct provided they are clearly labeled and understood by the user as being based on **either** scheduled hours or productive hours (Lussier 1965).

Method 3: The fixed cost of a machine per year is divided by the scheduled hours per year, and the operating cost per year is divided by the productive hours per year, and the sum of the results is used as the machine rate per hour.

$$HMC/? = \frac{FC/year}{SH/year} + \frac{OC/year}{PH/year}$$

Lussier (1965) emphasizes that Method 3 is incorrect for calculating an hourly machine rate from both a realistic and mathematical standpoint and can lead to very serious errors when used in logging cost analysis.

Modified Method 3: The $\frac{FC/year}{SH/year}$ is multiplied by the number of scheduled hours in the time period and the $\frac{OC/year}{PH/year}$ is multiplied by the PH in the time period and the sum of the products is the production cost for the time period. The production cost divided by the number of units of product produced during the time period gives the unit production cost.

$$\text{Cost/Production Unit for any time period} = \frac{\left(\frac{\text{FC/year}}{\text{SH/year}} \times \text{SH in time period}\right) + \left(\frac{\text{OC/year}}{\text{PH/year}} \times \text{PH in time period}\right)}{\text{Number of units of Production in time period}}$$

The authors suggest that if a Modified Method 3 is used as above, **not** to find the equipment's hourly machine rate, but to obtain production cost per unit for short time intervals, (i.e., daily, weekly, monthly, etc.) it appears to calculate production cost more accurately and realistically than either Method 1 or 2, as illustrated below.

Discussion and Illustration—A Single Machine

To illustrate the discrepancies caused by the methods of calculating cost and machine rates, a hypothetical skidder can be used as an example. The following assumptions are made:

Scheduled hours (SH) 1,920/year
Productive hours (PH) . . 1,248/year
Fixed cost (FC) $12,000/year
Operating cost (OC) $13,000/year
Machine utilzation (U) . . . $\frac{PH}{SH} = \frac{1248}{1920} = .65$ or 65%
Total production . . . . . 7,680 cd./yr @ 65% utilization
Cost per cord . . . . . $\frac{\$12,000 + \$13,000}{7,680 \text{ cd.}} = \$3.26$/cord.

Hypothetical monthly scheduled hours, productive hours, and monthly production volume for an entire year are summarized (table 1). Machine utilization varies from a January low of 25 percent to a June high of 84, with 65 percent average annual utilization. Monthly production ranges from 200 to 830 cords. Data from table 1 show how the monthly fixed and operating costs and the production cost per cord differ from month to month when calculated by Method 1, Method 2, and Modified Method 3.

Using Method 1

$$\text{Hourly Machine Cost (HMC/SH)} = \frac{\text{Fixed Cost (FC)} + \text{Operating Cost (OC)}}{\text{Scheduled Hours (SH)}}$$

$$= \frac{\$12,000 + \$13,000}{1,920 \text{ hours}}$$

$$= \$13.02/\text{SH}$$

Then the total machine cost for January is $13.02/SH × 160 SH = $2,083.33. Cost per cord in January = $2,083.33 ÷ 200 cd. = $10.42 per cord. Fixed and operating costs and cost per cord are calculated for other months, and the results shown in columns 2 and 7 of table 2.

Table 1.—*Hypothetical monthly data scheduled hours (SH), productive hours (PH), machine utilization (U), and monthly production (P)*

Month	SH	PH (Cumulative)		Machine utilization (U)	Production (P)
				Percent	*Cords*
January	160	40		25	200
February	160	72	(112)	45	465
March	160	115	(227)	72	732
April	160	120	(347)	75	830
May	160	130	(477)	81	781
June	160	135	(612)	84	740
July	160	130	(742)	81	790
August	160	118	(860)	74	600
September	160	124	(984)	78	800
October	160	104	(1,088)	65	714
November	160	84	(1,172)	53	628
December	160	76	(1,248)	48	400
Yearly Total	1,920	1,248		Ave.—65	7,680

Using Method 2

$$\text{Hourly Machine Cost (HMC/PH)} = \frac{\text{Fixed Cost (FC)} + \text{Operating Cost (OC)}}{\text{Production Hours (PH)}}$$

$$= \frac{\$12,000 + \$13,000}{1,248 \text{ hours}}$$

$$= \$20.03/\text{PH}$$

For January, the total machine cost is $20.03 per PH × 40 PH = $801.20. Cost per cord is $801.20 ÷ 200 cd. = $4.01 per cord. Similarly, fixed and operating costs and cost per cord are calculated for the other months and the results shown in columns 3 and 8 of table 2.

Using Modified Method 3

With fixed cost based on scheduled time and operating cost based on productive time, the formula is:

$$\text{Machine Cost per month} = \left(\frac{FC}{SH} \times \text{SH/month}\right) + \left(\frac{OC}{PH} \times \text{PH/month}\right)$$

$$= \left(\frac{\$12,000}{1,920} \times 160\right) + \left(\frac{\$13,000}{1,248} \times 40\right)$$

$$= (\$6.25 \times 160) + (\$10.42 \times 40)$$

$$= \$1,000.00 + \$416.67$$

$$= \$1,416.67 \text{ Total Machine Cost for January.}$$

Table 2.—*Fixed and operating cost and production cost of three alternative costing methods*

Month	Fixed and Operating Cost					Production Cost		
	First Method	Second Method	Modified Third Method			First Method	Second Method	Third Method
			Fixed	Operating	Total			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Dollars per month					Dollars per cord		
January	2,083.33	801.20	1,000	416.67	1,416.67	10.42	4.01	7.08
February	2,083.33	1,442.31	1,000	750.00	1,750.00	4.48	3.10	3.76
March	2,083.33	2,303.69	1,000	1,197.92	2,197.92	2.85	3.15	3.00
April	2,083.33	2,403.85	1,000	1,250.00	2,250.00	2.51	2.90	2.71
May	2,083.33	2,604.17	1,000	1,354.17	2,354.17	2.67	3.33	3.01
June	2,083.33	2,704.33	1,000	1,406.25	2,406.25	2.82	3.65	3.25
July	2,083.33	2,604.17	1,000	1,354.17	2,354.17	2.64	3.30	2.98
August	2,083.33	2,363.78	1,000	1,229.17	2,229.17	3.47	3.94	3.72
September	2,083.33	2,483.97	1,000	1,291.67	2,291.67	2.60	3.10	2.86
October	2,083.33	2,083.33	1,000	1,083.33	2,083.33	2.92	2.92	2.92
November	2,083.33	1,682.69	1,000	875.00	1,875.00	3.32	2.68	2.99
December	2,083.33	1,522.44	1,000	791.67	1,791.67	5.21	3.81	4.48
Yearly total[1]	25,000	25,000	12,000	13,000	25,000			

[1] Nearest full dollar.

Therefore, January production cost per cord is $1,416.67 ÷ 200 cd. = $7.08.

The fixed and operating costs and the cost per cord are similarly calculated for each other month as shown in columns 4, 5, 6, and 9 of table 2.

Although Modified Method 3 **cannot** be used to determine the machine rate per hour, unlike Methods 1 and 2, it **can** be used to determine total production cost for short intervals (daily, weekly, monthly, etc.), and when production cost for the interval is divided by the units produced during the interval, production cost per unit will be determined.

Examination of columns 7, 8, and 9 in table 2 shows marked differences in the cord cost calculated by each method. Cord production cost calculated by Method 1 shows the greatest range, from a low of $2.51 to $10.42. Cord cost calculated by Method 2 varied the least, from $2.68 to $4.01. Cord production cost calculated by Modified Method 3 varied from $2.71 to $7.08. Loggers using any one of these methods (Method 1 and 2 are common) should get similarly differing costs. Since the figures vary so much, it is necessary to determine which are correct and how they should be used.

In October, when the monthly machine utilization corresponded to the yearly utilization of 65 percent, all three methods of calculation resulted in the same total cost and the same production cost per cord.

Total annual cost by each method ($25,000) divided by yearly volume (7,680 cords) results in a weighted average production cost per cord of $3.26. In bidding for timber, most operators would use the $3.26 annual average as their logging cost in calculating the bid price. However, table 2 shows that monthly skid cost per cord can vary greatly from the $3.26/cord average and thus this figure would be unreliable when used for periods of less than 1 year.

Figure 2 shows that Method 1 gives a total cost per month that is constant, and not affected by the number of Productive Hours or volume of production for any month. Total monthly machine cost calculated by Method 2 shows the widest monthly values range—it was the lowest of the three methods when machine utilization was below 65 percent and the highest when machine utilization for the month was above the yearly average utilization.

Total machine costs per month calculated by Modified Method 3 were midway between those of Method 1 and Method 2. Where the machine utilization for October is identical to the yearly machine utilization of 65 percent, total cost for all three calculation methods is the same.

Figure 3 shows that monthly per cord cost calculated by Method 1 is highest in the months of lowest machine utilization, and lowest in the months of higher than average machine utilization. Method 2

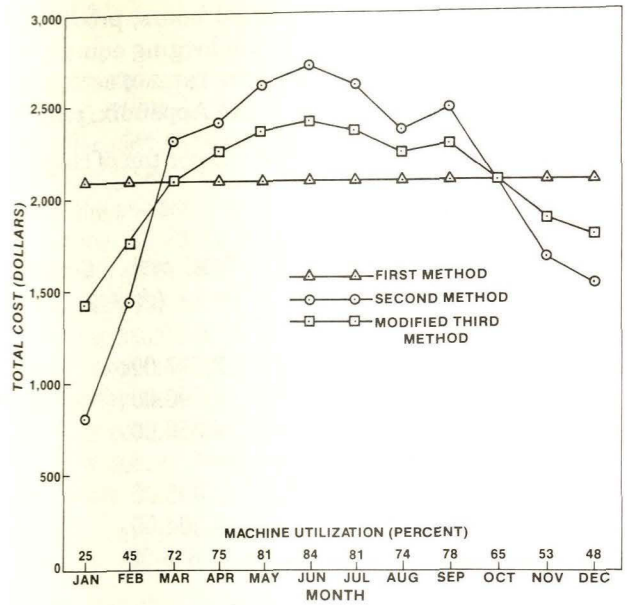

Figure 2.—*Total cost for each month as calculated by each of three methods.*

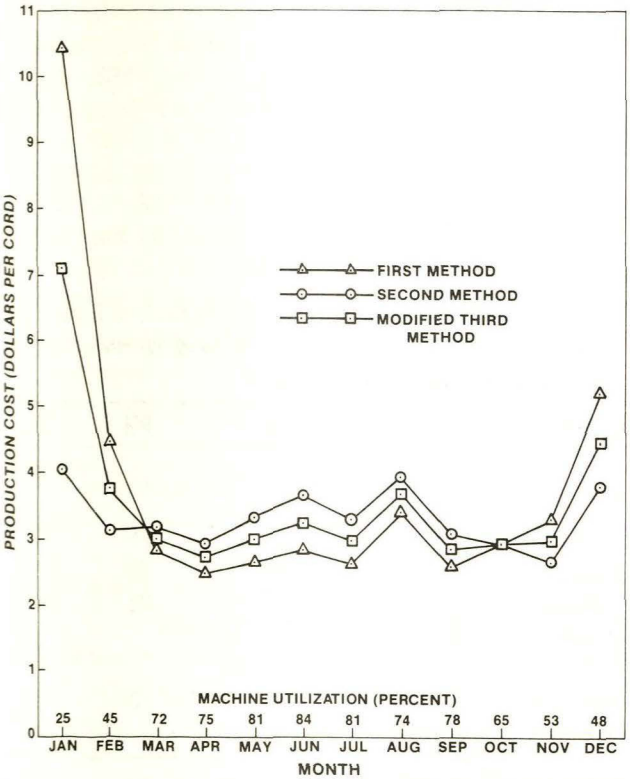

Figure 3.—*Production cost per cord for each month as calculated by each of three methods.*

yields the lowest cost per cord with very low machine utilization and the highest cost with high machine utilization and production. Modified Method 3 gives an intermediate cost per cord.

Any of the three methods of calculation would produce the same average production cost per cord for the total yearly production, i.e., $3.26 per cord. However, if we use the $3.26 value to estimate equipment costs per cord for time periods shorter than a year, markedly different production costs per cord are obtained by the these methods (tables 1 and 2 and figs. 2 and 3). Therefore, the average yearly cost of production per cord is not recommended for estimating production costs for less than one year when production varies widely from month to month.

Method 1 has a constant total cost in every month regardless of the number of hours the machine is productively used or the volume of wood produced (table 2, fig. 2). Since operating costs **are** obviously incurred when the machine is utilized for production, equipment cost should not be constant for every month, but rather operating costs should be proportional to the productive hours.

In Method 2, unlike Method 1, all equipment costs were divided by total productive hours. In other words, equipment costs occur only when the equipment is used. The fixed costs however, should be charged whether or not the equipment is used. This method is currently used widely in North America. Method 2 is useful in making cost comparisons for two or more alternative machines. The biggest disadvantage of Method 2 is it cannot be applied when a machine is not in actual use.

Modified Method 3 best follows the true nature of cost in that the fixed cost is applied for all the scheduled hours, whether the machine works or not, while operating costs are calculated only for working hours.

By using Modified Method 3 to determine timber harvesting production costs, more realistic cost values are obtained for short time periods and under variable timber stand conditions. Use of Modified Method 3 also takes into account costs incurred by standby or when a machine is not in use.

Discussion and Illustration—A Logging System Case Study

When the three methods are applied to an entire logging system, similar results occur. The following assumptions are made:

A pole-sized stand of northern hardwoods is to be clearcut to create a debris-free planting site while

maximizing raw-material recovery return. Wood from the present stand is to be sold as whole-tree chips. To clearcut the stand, two 5-day weeks at 10 hours a day, or 100 hours, are required. Two thousand tons of chips are produced from this stand. Hauling distance is 30 miles one way.

In the following calculations of production costs for each of the three methods, transportation costs (based on dollars per mile) are included because, though they do not affect the final comparisons of three methods, they are a part of the cost of production per ton of chips delivered at the mill.

The harvesting equipment and labor required are as follows:

Equipment:	Labor:
1 feller/buncher with accumulating head,	1 feller/buncher operator,
1 wheeled grapple skidder,	1 skidder operator,
1 standby wheeled grapple skidder,	1 chipper operator,
1 whole-tree chipper,	3 truck drivers,
3 truck-tractor units,	1 foreman
4 chip vans,	
1 fuel truck,	
1 maintenance van.	

The scheduled and productive hours, utilization of the equipment, and purchase price of the equipment are summarized on a yearly basis (table 3).

Table 4 presents the scheduled hours, productive hours, and utilization rate of the logging equipment used to complete this job. Machine rates of each piece of equipment are presented in the Appendix, page 9.

Calculation of cost of production per ton of chips at the mill:

Method 1	Total cost	Cost/ton
	------- *(dollars)* -------	
Feller/buncher ($27.97/SH × 100 SH)	2,797.00	1.40
Skidder ($27.90/SH × 100 SH)	2,790.00	1.40
Chipper ($43.50/SH × 100 SH)	4,350.00	2.17
Standby skidder ($14.95 FC/SH × 100 SH)	1,495.00	.75
Trucking ($0.73/mi × 4800 mi)	3,504.00	1.75
Chip van ($0.17/mi × 4800 mi)	816.00	.41
Fuel truck (($0.19/SH + $0.48/SH) × 100 SH)	67.00	.03
Standby maintenance vehicle ($0.27/SH × 100 SH)	27.00	.01
Total, excluding labor	15,846.00	7.92
Labor costs	5,800.00	2.90
Total, including labor	21,646.00	10.82

Table 3.—*Scheduled and productive hours for the equipment on a yearly basis*

Equipment	SH	PH	Machine Utilization (U)	Purchase price/unit
			Percent	*Dollars*
1 Feller/buncher	2,000	1,300	65	130,000
2 Skidders	2,000	1,340	67	85,000
1 Chipper	2,000	1,500	75	160,000
3 Truck units	40,000 mi/yr			45,000 ea
4 Chip vans	20,000 mi/yr			12,000 ea
1 Fuel truck	2,000	400	20	1,500
1 Maintenance vehicle	2,000	—	—	2,000

Table 4.—*Actual scheduled and productive hours for the equipment for the 2-week period required to clearcut the case study stand*

Equipment	SH	PH	U
			Percent
1 Feller/buncher	100	75	75
2 Skidders	100	80	80
1 Chipper	100	85	85
3 Truck units	4,800 miles		
4 Chip vans	4,800 miles		
1 Fuel truck	100	20	20
1 Maintenance vehicle	100	—	—

Labor cost: $8/SH for operator
Foreman cost: $10/SH for one foreman

Method 2	Total cost	Cost/ton
	------- (dollars)	-------
Feller/buncher ($43.02/PH × 75 PH)	3,226.50	1.61
Skidder ($41.64/PH × 80 PH)	3,331.20	1.67
Chipper ($58.01/PH × 85 PH)	4,930.85	2.47
Standby skidder[1]	—	—
Trucking ($0.73/mi × 4800 mi)	3,504.00	1.75
Chip van ($0.17/mi × 4800 mi)	816.00	.41
Fuel truck ($3.34/PH × 20 PH)	66.80	.03
Standby maintenance vehicle[1]	—	—
Total, excluding labor and standby vehicles	15,875.35	7.94
Total cost of standby skidder	1,495.00	.75
Total cost of maintenance vehicle	27.00	.01
Total, excluding labor	17,397.35	8.70
Labor costs	5,800.00	2.90
Total, including labor	23,197.35	11.60

Modified Method 3	Total cost	Cost/ton
	------- (dollars)	-------
Feller/buncher ($18.36/SH × 100) + ($14.78/PH × 75)	2,944.50	1.47
Skidder ($14.95/SH × 100) + ($19.33/PH × 80)	3,041.40	1.52
Chipper ($22.42/SH × 100) + ($28.11/PH × 85)	4,631.35	2.32
Standby skidder ($14.95/SH × 100) + (0/PH × 85)	1,495.00	.75
Trucking ($0.73/mi × 4800)	3,504.00	1.75
Chip van ($0.17/mi × 4800)	816.00	.41
Fuel truck ($0.19/SH × 100) + ($2.37/PH × 20)	66.40	.03
Maintenance vehicle	27.00	.01
Total, excluding labor	16,525.65	8.26
Labor costs	5,800.00	2.90
Total, including labor	22,325.65	11.16

Summarizing the total cost obtained by the three methods (costs for 10 days):

Method 1—
$10.82/ton × 2,000 tons = $21,640

Method 2—
$11.60/ton × 2,000 tons = $23,200

Modified Method 3—
$11.16/ton × 2,000 tons = $22,320

$1,560 (Method 1 − Method 2)

$880 (Method 2 − Modified Method 3)

$680 (Method 1 − Modified Method 3)

[1]*Cannot be calculated by Method 2.*

There is a $1,560 difference in total costs between Method 1 and 2, an $880 difference between Method 2 and Modified Method 3, and a $680 difference between Method 1 and Modified Method 3 in this 10-day period. Therefore, it can be concluded that calculation of logging costs by Methods 1, 2, and Modified Method 3 have the same effect on cost differentials for a complete logging system as they have on a single piece of equipment.

CONCLUSION

Due to the intense competition of securing stumpage, loggers must accurately estimate production costs over short time intervals and for changing stand conditions in order to submit enough successful bids to be able to schedule harvest under favorable seasonal conditions insuring maximum profitability.

In this paper, three methods of equipment costing are discussed and the cost differentials resulting from Method 1, 2, and Modified Method 3, are demonstrated by calculating logging cost for a single piece of equipment and for an entire logging system. Methods 1 and 2 should be used to calculate the machine rate for equipment as long as it is clearly understood the rate is based upon either scheduled hours or productive hours. Modified Method 3 **cannot** be used to calculate an hourly machine rate, but is useful and realistic when used to calculate production costs for time periods of less than 1 year.

BIBLIOGRAPHY

Anonymous. 1979. Associated Oregon loggers' annual meeting. Membership told to study operating costs. Timber Harvesting 27(5):46-47.

Bennet, W. D., and H. I. Winer. 1967. Cost analysis in logging. Pulp and Paper Magazine of Canada. Woodland Review, Convention Issue 68(3):80-94.

Lussier, Louis-Jean. 1965. Pitfalls in logging cost analysis. Pulp and Paper Magazine of Canada, Woodland Review 66(11):478-482.

Mathiews, Donald M. 1942. Cost control in the logging industry. 374 p. McGraw Hill Book Company, Inc., New York, New York.

Miyata, Edwin S. 1980. Determination of fixed and operating costs of logging equipment. U.S. Department of Agriculture Forest Service, General Technical Report NC-56, 17 p. U.S. Department of Agriculture Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

Rolston, K. S. 1968. Standard definitions for machine availability and utilization. American Pulpwood Association, Technical Release 68-R-10. 4 p. Washington, D.C.

Warren, Jack. 1977. Logging cost analysis, timber harvesting short course. Timber harvesting Rep. 4 LSU/MSU Logging and Forestry Operations Center, Bay St. Louis, Missouri.

APPENDIX

MACHINE RATE

Based on yearly. Productive Hours (PH) and Scheduled Hours (SH)

I. Description

Type Track Type Feller/Buncher Model _____ H.P. 145

Purchase Cost: $ 130,000
Less: Tire Cost $ N.A.
TOTAL INITIAL INVESTMENT (P) = $ 130,000

Salvage Value (S) (20 % of P) = $ 26,000
Estimated Life (n) 5 years
Working days per year 250 days

Scheduled hours/yr (SH) 2,000 hr
Utilization (U) 65 %
Productive hours/yr (PH) 1,300 hr

Average Value of Investment (AVI) = $\frac{(P-S)(n+1)}{2n} + S$ = $ 88,400 /yr

II. Fixed Cost

Depreciation (D) = $\frac{P - S}{n}$ = $ 20,800 /yr

Interest 12 %
Insurance 3 %
Taxes 3 %
Total = 18 % x AVI $ 88,400 /yr = $ 15,912 /yr

TOTAL FIXED COST PER PH = $\frac{D + IIT}{PH}$ = $ / 28.24 /PH /

TOTAL FIXED COST PER SH = $\frac{D + IIT}{SH}$ = $ / 18.36 /SH /

III. Operating Cost

Maintenance & Repair (50 % of $\frac{P - S}{nPH}$) = $ 8.00 /PH

Fuel Cost = 145 hp x 0.037 x $0.95 = $ 5.10 /PH

Oil & Lubrication (assume 33% of fuel cost) = $ 1.68 /PH

Tires = $\frac{1.15^{1/} \text{ x tire cost}}{\text{total tire life in hr}}$ = $ -

TOTAL OPERATING COST PER PH = $ / 14.78 /PH /

x U .65

TOTAL OPERATING COST PER SH = $ / 9.61 /SH /

1/ 15% labor cost to repair or replace tires

MACHINE RATE

Based on yearly. Productive Hours (PH) and Scheduled Hours (SH)

I. Description

Type Wheeled Grapple Skidder Model _____ H.P. 140

Purchase Cost: $ 85,000
Less: Tire Cost $ 10,000 @ $2,500 ea)
TOTAL INITIAL INVESTMENT (P) = $ 75,000

Salvage Value (S) (20 % of P) = $ 15,000
Estimated Life (n) 3 years
Working days per year 250 days

Scheduled hours/yr (SH) 2,000 hr
Utilization (U) 67 %
Productive hours/yr (PH) 1,340 hr

Average Value of Investment (AVI) = $\frac{(P-S)(n+1)}{2n} + S$ = $ 55,000 /yr

II. Fixed Cost

Depreciation (D) = $\frac{P - S}{n}$ = $ 20,000 /yr

Interest 12 %
Insurance 3 % } IIT
Taxes 3 %
Total = 18 % x AVI $ 55,000 /yr = $ 9,900 /yr

TOTAL FIXED COST PER PH = $\frac{D + IIT}{PH}$ = $ / 22.31 /PH /

TOTAL FIXED COST PER SH = $\frac{D + IIT}{SH}$ = $ / 14.95 /SH /

III. Operating Cost

Maintenance & Repair (60 % of $\frac{P - S}{nPH}$) = $ 8.96 /PH

Fuel Cost = 140 hp x 0.037 x $0.95 = $ 4.92 /PH

Oil & Lubrication (assume 33% of fuel cost) = $ 1.62 /PH

Tires = $\frac{1.15^{1/} \text{ x tire cost}}{\text{total tire life in hr}} = \frac{1.15 \times 10{,}000}{3{,}000}$ = $ 3.83

TOTAL OPERATING COST PER PH = $ / 19.33 /PH /

x U .67

TOTAL OPERATING COST PER SH = $ / 12.95 /SH /

1/ 15% labor cost to repair or replace tires

MACHINE RATE

Based on yearly. Productive Hours (PH) and Scheduled Hours (SH)

I. Description

Type Whole-tree Chipper Model _____ H.P. 380

Purchase Cost: $ 160,000
Less: Tire Cost $ 1,200 (8 tires @ $150 ea)
TOTAL INITIAL INVESTMENT (P) = $ 158,800

Salvage Value (S) (20 % of P) = $ 31,760
Estimated Life (n) 5 years
Working days per year 250 days

Scheduled hours/yr (SH) 2,000 hr
Utilization (U) 75 %
Productive hours/yr (PH) 1,500 hr

Average Value of Investment (AVI) = $\frac{(P-S)(n+1)}{2n} + S$ = $ 107,984 /yr

II. Fixed Cost

Depreciation (D) = $\frac{P - S}{n}$ = $ 25,408 /yr

Interest 12 %
Insurance 3 % } IIT
Taxes 3 %
Total = 18 % x AVI $ 107,984 /yr = $ 19,437.12 /yr

TOTAL FIXED COST PER PH = $\frac{D + IIT}{PH}$ = $ / 29.90 /PH /

TOTAL FIXED COST PER SH = $\frac{D + IIT}{SH}$ = $ / 22.42 /SH /

III. Operating Cost

Maintenance & Repair (60 % of $\frac{P - S}{nPH}$) = $ 10.16 /PH

Fuel Cost = 380 hp x 0.037 x $0.95 = $ 13.36 /PH

Oil & Lubrication (assume 33% of fuel cost) = $ 4.41 /PH

Tires = $\frac{1.15^{1/} \text{ x tire cost}}{\text{total tire life in hr}} = \frac{1.15 \text{ x } 1200}{7500}$ = = $ 0.18

TOTAL OPERATING COST PER PH = $ / 28.11 /PH /

x U .75

TOTAL OPERATING COST PER SH = $ / 21.08 /SH /

1/ 15% labor cost to repair or replace tires

MACHINE RATE
Based on yearly Scheduled Hours (SH)

I. Description

Type Tractor-Truck Unit Model _____ H.P. 350

Purchase Cost: $ 45,000
Less: Tire Cost $ 1,600
TOTAL INITIAL INVESTMENT (P) = $ 43,400.00

Salvage Value (S) (20)% of P) = $ 8,680.00
Estimated Life (n) 4 yr
Working days per year _____ days
Total tire life 40,000 mi

Scheduled Hours/yr (SH) 2,000 hr
Operating Miles/yr (M) 40,000 mi/yr
Productive Hours/yr (PH) _____ hr
Average hauling distance (one way) _____ mi
Number of loads per day _____ /day

Average Value of Investment (AVI) = $\frac{(P-S)(n+1)}{2n} + S$ = $ 30,380.00 /yr

II. Fixed Cost

Depreciation (D) = $\frac{P - S}{n}$ = $ 8,680.00 /yr

Interest 12 %
Insurance 3 %
Taxes 3 %
Total 18 % x AVI $ 30,380.00 /yr = $ 5,468.40 /yr

TOTAL FIXED COST PER MILE = $\frac{D + IIT}{M}$ = $ / 0.35 /mi /

TOTAL FIXED COST PER SH = $\frac{D + IIT}{SH}$ = $ / 7.07 /SH /

III. Operating Cost

Maintenance & Repair (50 % of $\frac{P - S}{nxM}$) = $ 0.11 /mi

Fuel Cost 4.53 mpg; $ 0.95 /gal = $ 0.21 /mi

Oil & Lubrication 800 mpg; $ 4.00 /gal = $ 0.01 /mi

Tires = $\frac{1.15^{1/} \text{ x tire cost}}{\text{total tire life in mi}} = \frac{1.15 \times 1600}{40,000}$ = $ 0.05 /mi

TOTAL OPERATING COST PER MILE = $ / 0.38 /mi /

TOTAL OPERATING COST PER SH = $\frac{\text{Tot. op. cost/mi x M}}{SH}$ = $ / 7.60 /SH /

TOTAL COST PER MILE = $ / 0.73 /mi /

TOTAL COST PER SH $ / 14.67 /SH /

1/ 15% labor cost to repair or replace tires

MACHINE RATE
Based on yearly Scheduled Hours (SH)

I. Description

Type Chip Van (25 ton cap.) Model _____ H.P. _____

Purchase Cost: $ 12,000
Less: Tire Cost $ 1,280
TOTAL INITIAL INVESTMENT (P) = $ 10,720.00

Salvage Value (S) (20)% of P) = $ 2,144.00
Estimated Life (n) 8 yr
Working days per year 250 days
Total tire life 40,000 mi

Scheduled Hours/yr (SH) 2,000 hr
Operating Miles/yr (M) 20,000 mi/yr
Productive Hours/yr (PH) _____ hr
Average hauling distance (one way) 30 mi
Number of loads per day _____ /day

Average Value of Investment (AVI) = $\frac{(P-S)(n+1)}{2n} + S$ = $ 6,968.00 /yr

II. Fixed Cost

Depreciation (D) = $\frac{P - S}{n}$ = $ 1,072.00 /yr

Interest 12 %
Insurance 3 % } IIT
Taxes 3 %
Total 18 % x AVI $ 6,968.00 /yr = $ 1,254.24 /yr

TOTAL FIXED COST PER MILE = $\frac{D + IIT}{M}$ = $ / 0.12 /mi /

TOTAL FIXED COST PER SH = $\frac{D + IIT}{SH}$ = $ / 1.16 /SH /

III. Operating Cost

Maintenance & Repair (10 % of $\frac{P + S}{nxM}$) = $ 0.005 /mi

Fuel Cost _____ mpg; $ _____/gal = $ - /mi

Oil & Lubrication _____ mpg; $ _____/gal = $ 0.001 /mi

Tires = $\frac{1.15^{1/} \text{ x tire cost}}{\text{total tire life in mi}}$ = = $ 0.04 /mi

TOTAL OPERATING COST PER MILE = $ / 0.046 or 0.05/mi /

TOTAL OPERATING COST PER SH = $\frac{\text{Tot. op. cost/mi x M}}{SH}$ = $ / 0.46 /SH /

TOTAL COST PER MILE = $ / 0.17 /mi /

TOTAL COST PER SH $ / 1.62 /SH /

1/ 15% labor cost to repair or replace tires

MACHINE RATE
Based on yearly Scheduled Hours (SH)

I. Description

Type Maintenance Truck Model _____ H.P. _____

Purchase Cost: $ 1,760
Less: Tire Cost $ _____
TOTAL INITIAL INVESTMENT (P) = $ 1,760.00

Salvage Value (S) (0)% of P) = $ -
Estimated Life (n) 5 yr
Working days per year 250 days
Total tire life 20,000 mi

Scheduled Hours/yr (SH) 2,000 hr
Operating Miles/yr (M) _____ mi/yr
Productive Hours/yr (PH) _____ hr
Average hauling distance (one way) _____ mi
Number of loads per day _____ /day

Average Value of Investment (AVI) = $\frac{(P-S)(n+1)}{2n} + S$ = $ 1,056.00 /yr

II. Fixed Cost

Depreciation (D) = $\frac{P - S}{n}$ = $ 352.00 /yr

Interest 12 %
Insurance 3 %
Taxes 3 %
Total 18 % x AVI $ 1,056.00 /yr = IIT = $ 190.08 /yr

TOTAL FIXED COST PER MILE = $\frac{D + IIT}{M}$ = $ / - /mi /

TOTAL FIXED COST PER SH = $\frac{D + IIT}{SH}$ = $ / 0.27 /SH /

III. Operating Cost

Maintenance & Repair (___% of $\frac{P + S}{nxM}$) = $ _____/mi

Fuel Cost _____ mpg; $ _____/gal = $ _____/mi

Oil & Lubrication _____ mpg; $ _____/gal = $ _____/mi

Tires = $\frac{1.15^{1/} \text{ x tire cost}}{\text{total tire life in mi}}$ = = $ _____/mi

TOTAL OPERATING COST PER MILE = $ /_____/mi /

TOTAL OPERATING COST PER SH = $\frac{\text{Tot. op. cost/mi x M}}{SH}$ = $ /_____/SH /

TOTAL COST PER MILE = $ /_____/mi /

TOTAL COST PER SH $ /_____/SH /

1/ 15% labor cost to repair or replace tires

MACHINE RATE
Based on yearly Scheduled Hours (SH)

I. Description

Type Fuel Truck Model _____ H.P. _____

Purchase Cost: $ 1,500
Less: Tire Cost $ 240
TOTAL INITIAL INVESTMENT (P) = $ 1,260.00

Salvage Value (S) (0)% of P) = $ -
Estimated Life (n) 5 yr
Working days per year 250 days
Total tire life 20,000 mi

Scheduled Hours/yr (SH) 2,000 hr
Operating Miles/yr (M) 5,000 mi/yr
Productive Hours/yr (PH) 400 hr
Average hauling distance (one way) _____ mi
Number of loads per day _____ /day

Average Value of Investment (AVI) = $\frac{(P-S)(n+1)}{2n} + S$ = $ 756.00 /yr

II. Fixed Cost

Depreciation (D) = $\frac{P - S}{n}$ = $ 252.00 /yr

Interest 12%
Insurance 3%
Taxes 3%
Total 18% x AVI $ 756.00 /yr = $ 136.08 /yr

TOTAL FIXED COST PER MILE = $\frac{D + IIT}{M}$ = $ / 0.08 /mi /

TOTAL FIXED COST PER SH = $\frac{D + IIT}{SH}$ = $ / 0.19 /SH /

TOTAL FIXED COST PER PH = $\frac{D + IIT}{PH}$ = $ / 0.97 /PH /

III. Operating Cost

Maintenance & Repair (100 % of $\frac{P - S}{nxM}$) = $ 0.05 /mi

Fuel Cost 8 mpg; $ 0.95 /gal = $ 0.12 /mi

Oil & Lubrication 400 mpg; $ 4.00 /gal = $ 0.01 /mi

Tires = $\frac{1.15^{1/} \text{ x tire cost}}{\text{total tire life in mi}} = \frac{1.15\ (240)}{20,000}$ = $ 0.01 /mi

TOTAL OPERATING COST PER MILE = $ / 0.19 /mi /

TOTAL OPERATING COST PER SH = $\frac{\text{Tot. op. cost/mi x M}}{SH}$ = $ / 0.48 /SH /

TOTAL OPERATING COST PER PH = $\frac{\text{Tot. op. cost/mi x M}}{PH} = \frac{.19 \times 5000}{400}$ = $ / 2.37 /PH /

TOTAL COST PER MILE = $ / 0.27 /mi /

TOTAL COST PER SH = $ / 0.67 /SH /

TOTAL COST PER PH = $ / 3.34 /PH /

1/ 15% labor cost to repair or replace tires

Miyata, Edwin S., and Helmuth M. Steinhilb.

1981. Logging system cost analysis: comparison of methods used. U.S. Department of Agriculture Forest Service, Research Paper NC-208, 15 p. U.S. Department of Agriculture Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

Several methods of calculating machine rates, costs, and productivity for both single pieces of logging equipment and for logging systems are discussed.

KEY WORDS: Harvesting, productivity, machine rates, scheduled hours, productive hours, economics.

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